

Transportation Asset Management

The Role of Engineering Economic Analysis

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Introduction

- The mission of the Federal Highway Administration's Office of Asset Management is to provide leadership and expertise in the systematic application of management and investment strategies for highway infrastructure assets
- Mission includes development of tools, techniques, and information on applications of Transportation Asset Management (TAM)



FHWA's Approach to TAM

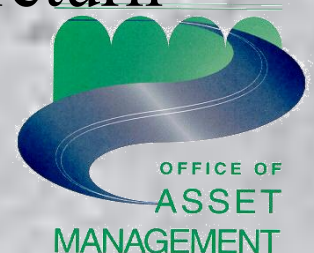
- Office works in cooperation with AASHTO and other national organizations in promoting TAM
 - In 1997, AASHTO requested that FHWA assist it with development of products and programs that could aid States in implementing TAM in their organizations
 - FHWA assisted AASHTO in the development of its strategic plan for Asset Management
- No national policy for TAM

What TAM Is

- Recent Thinking – TAM is a strategic approach to the optimal allocation of resources for the management, operation, and preservation of transportation infrastructure
- There are other definitions of TAM, but most specify a common goal of making better resource allocation decisions with better information

“Better Resource Allocation Decisions”

- What constitutes a better resource allocation decision?
 - “Cost-effective” solutions are frequently cited as desired standard
 - “Economically efficient” allocation of resources
 - “Optimal” allocation or “highest rate of return on investment”

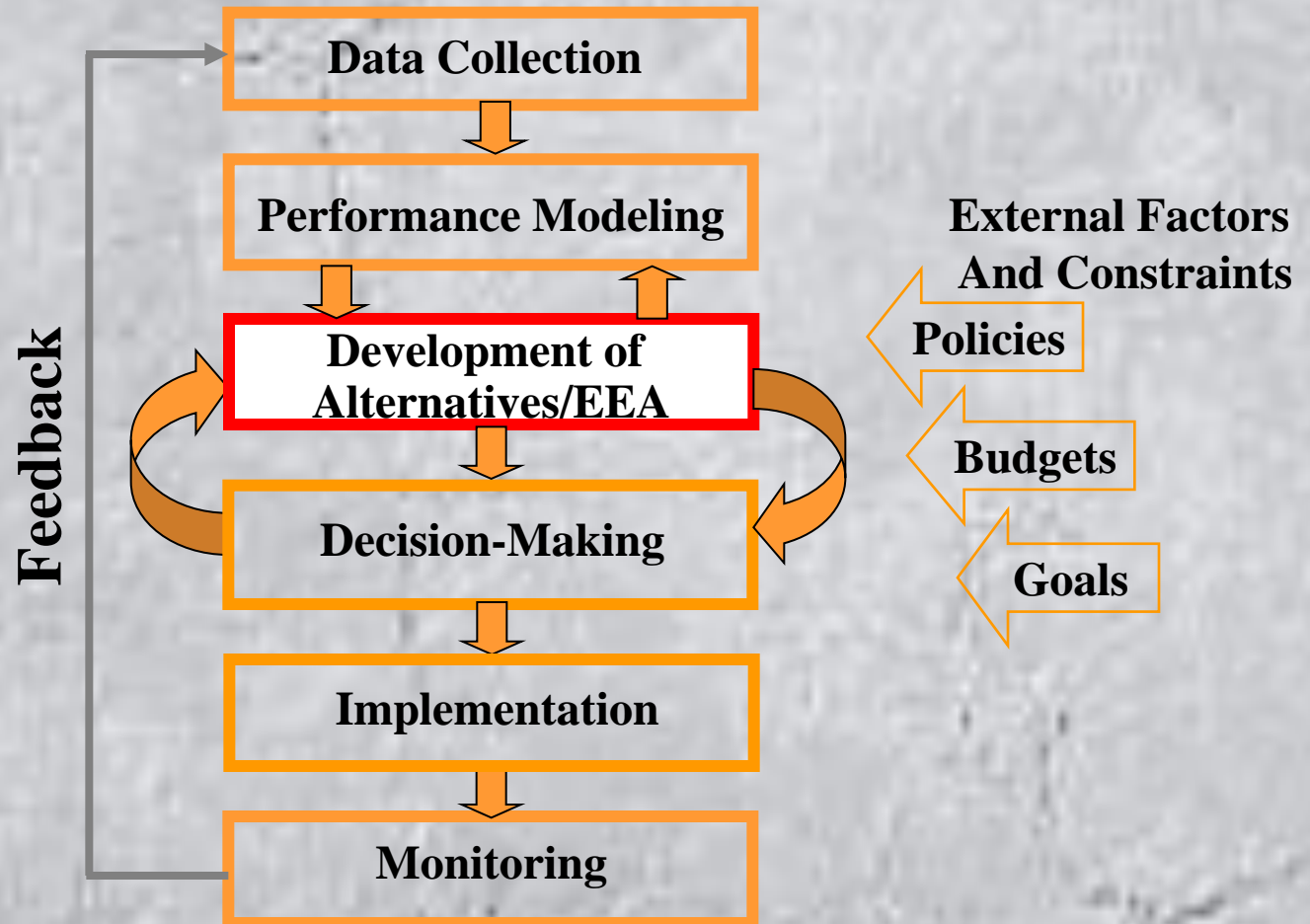


Where EEA Fits in TAM

- TAM requires an integrated decision-making process of which EEA is a critical part
- EEA directly addresses the core reason we undertake transportation projects – the creation of net benefits for the traveling public and society at large
- EEA will not work without good data and performance modeling



Asset Management: Where EEA Fits



EEA Informs Decision Maker

- Note that diagram does not show EEA at Decision Maker level
- EEA informs Decision Maker but does not make the decision
 - Decisions will be based on a host of factors, including policies, budgets, and goals
- If EEA is done correctly, it will reflect agency goals and objectives and answer Decision Maker questions about resource allocations



EEA Tools

- EEA provides a tool kit for better allocation of resources through TAM framework
- Tools range in complexity and scope
 - Discounting
 - Life Cycle Cost Analysis/value engineering
 - Benefit-Cost Analysis
 - Applications in economic development studies
- As in any tool kit, use of the right tool saves time and effort



Discounting

- Discounting is the backbone of EEA
- Use of a discount rate facilitates comparison of the costs and benefits of alternative transportation projects over time
- Dollars can be:
 - Relocated in time
 - Any combination of flows can be summed into a single value at a single point in time
 - Lump sums can be converted to annual flows
- Discount rate is distinct from inflation rate



Life Cycle Cost Analysis (LCCA)

- LCCA is discounting applied to the cost side of an investment decision
- LCCA should be applied once a decision to undertake an improvement has been reached, but the method of implementing the improvement is undecided
 - All reasonable design alternatives should be evaluated over identical analysis periods
 - Benefits of design alternatives must be equivalent
 - Analysis of differences in life cycle costs only



LCCA Steps

- Step 1: Establish design alternatives
- Step 2: Determine activity timing
- Step 3: Estimate costs (Agency and user)
- Step 4: Discount life cycle costs
- Step 5: Analyze the results

Potential Applications of LCCA

- Pavement design (choice between pavement types)
- Pavement and Bridge Management Systems may have LCCA capabilities
- Selection of pavement preservation strategies
- Bridge replacement



Benefits of LCCA

- In many cases, there is no question that an improvement must be made—the question concerns only what is most cost-effective means to do it
 - A failing bridge that must be replaced
 - Cost-effective solution will likely be optimal investment of resources in asset preservation
- Practice of LCCA promotes broader use of EEA tools
- LCCA is “disciplining framework” for review and discussion of project design alternatives



Economic Concepts in LCCA

- LCCA introduces following economic concepts
 - Notion of long term, as represented by “life cycle”
 - Risk analysis
 - Best practice LCCA specifically addresses costs to users associated with work zones and maintenance



Limitations of LCCA

- Cannot compare design alternatives that have different benefits (e.g., reconstruct road vs. reconstruct road with widening)
- Cannot, of itself, answer question of whether an improvement is worth pursuing (i.e. the project has a positive net present value)

LCCA Products

- Numerous commercial products are available to do LCCA
 - Range from simple spreadsheets to component management systems to specialized project analysis programs
 - FHWA has issued the Life-Cycle Cost Analysis in Pavement Design Interim Technical Bulletin and will soon be releasing an LCCA model that incorporates risk analysis

Benefit-Cost Analysis (BCA)

- The discounted value of project's life cycle benefits is compared to the discounted value of its life cycle costs
- Different measures are used to compare benefits to costs
 - Net present value (NPV)
 - Benefit-cost ratio (B/C)
 - Equivalent Uniform Annual Value
 - Internal rate of return (IRR)

Applications of BCA

- BCA is used to address the following resource allocation decisions:
 - Whether or not to pursue an improvement
 - Select among design alternatives with different benefits
 - Select among competing projects in same mode
 - Select among competing projects in different modes



Key Role of Discount Rate in BCA

- Discount rate reflects the productivity of capital, people's preferences for current over future consumption, and the scarcity of investable resources
- If an investment doesn't yield discounted benefits that exceed discounted costs, this means resource allocation is not economically efficient

How to Get to “Optimal” with BCA

- Optimization is possible with BCA
 - Apply BCA to all reasonable project design alternatives
 - Use appropriate discount rate
 - Identify all significant benefits and costs
 - Quantify all benefits and costs to degree possible, consider all else qualitatively
 - Use appropriate means to compare costs and benefits for identical analysis periods



BCA and Unconstrained Budget

- Unconstrained budget
 - Apply BCA to all reasonable project design alternatives
 - Pursue project design alternative with highest positive NPV
 - Pursue all projects where at least one design alternative has positive NPV
- Useful in identifying project inventories

BCA and Constrained Budget

- Constrained budget
 - Similar to unconstrained budget application of BCA except that analyst must select among design alternatives of multiple projects to obtain highest overall rate of return (NPV) for fixed investment levels
 - Design alternatives and projects are selected according to highest B/C ratio
 - Not all projects with positive NPVs will be pursued
 - Calculation can become complicated for large programs



Challenges of BCA

- Calculation of benefits and costs over life cycle is often difficult
 - Agency costs associated with projects can be hard to ascertain
 - User costs and benefits are critical
 - User benefits are purpose for building the road but may be hard to measure and value
 - Uncertain forecasts of traffic, delays, and crash rates
 - Valuation of time and safety is often controversial
 - Externalities and social impacts resist quantification
 - Network effects and induced demand



Benefits of BCA

- Given challenges, why pursue BCA?
 - Desire to get best return from scarce resources
 - With respect to the imprecision of estimates, *not* doing benefit-cost analysis does not lessen uncertainties; it only masks them
 - By quantifying those costs and benefits that can be monetized, BCA provides stronger basis for making qualitative judgments about the importance of non-monetized benefits



Tips for Good Quality BCA

- Do not start with predetermined conclusion
- Clearly define problem, realistic baseline (no build), all reasonable alternatives, and benefits and costs measures
- Monetize benefits and costs as much as possible, without regard to source of funds
- Use credible data
- Deal appropriately with uncertainty
- Communicate results understandably



BCA Products

- Numerous BCA programs are available for project level analysis
 - AASHTO Redbook and other guides
 - MicroBENCOST implements AASHTO Redbook
 - State Agency-developed models such as Caltrans' CalBC, WSDOT Benefit/Cost software, etc.
- Corridor or system level models such as STEAM, StratBENCOST, and Net BC
- FHWA has issued the Highway Economic Requirements System/State Version (HERS/ST) model for program level BCA



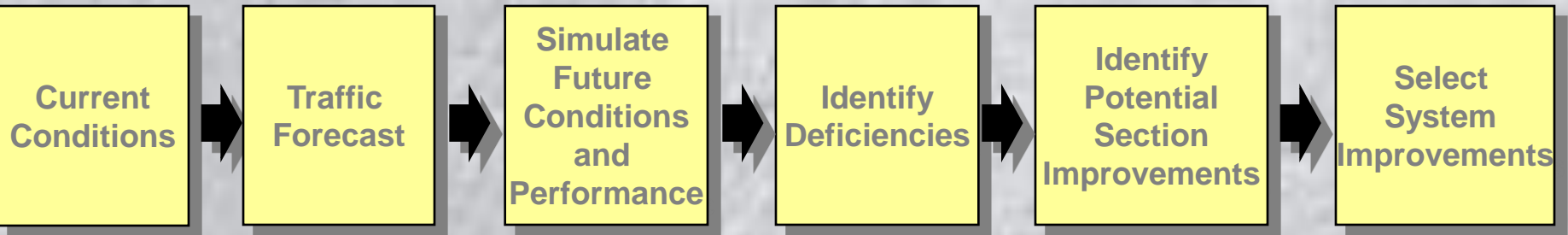
HERS/ST

- HERS/ST is a direct extension of the national-level HERS model
 - Applies BCA to the selection and implementation of highway capital improvements
 - Provides a common, objective platform for State DOTs to communicate with State legislatures and other officials regarding the impacts of alternative highway investment levels
 - Analysis is rigorous and considers travel time, safety, vehicle operating, emissions, and highway agency costs



HERS/ST Logic

OVERVIEW



Use of HERS/ST

- The HERS/ST software has been tested by 17 States and is now being revised in response to their comments
- A national conference will be held in the Fall of 2002 to deliver the model to all 50 states

Note on Risk Analysis

- Risk analysis is not a separate EEA tool, but is a means of addressing uncertainty associated with economic outcomes in LCCA or BCA
 - Probabilistic LCCA and BCA allow the value of individual data inputs to be defined by a frequency (probability) distribution
 - An entire probability distribution of NPVs is generated for the project alternative along with the mean or average NPV for that alternative
- Helps to resolve issues associated with uncertainty about user costs and future demand



Economic Development Analysis

- BCA typically does not incorporate or reveal data on economic development impacts
- Consensus among economists is that accounting for user costs and benefits also captures other value-adding effects of transportation improvements (which are transfers from users)
- However, Decision Makers often want information on how transferred benefits will affect jobs, personal income levels, tourism, property development, etc., at the local level
- Development analysis complements BCA



Reasons for Development Analysis

- Benefits and costs experienced at local level are important investment decision criteria
 - How benefits affect locality and State
 - Specific groups may be affected adversely
- Legally-mandated planning and regulatory review
- Public education
- Post-project evaluation



Economic Development Impact

- Transportation investment is often viewed as a means to promote economic development
 - There is a healthy debate as to the impact of new transportation investment on economic development at the national level
 - Strong effects in 1950's and 1960's
 - Since 1980, stimulus effects remain but have declined
 - Effects are very pronounced at local level, where most studies reveal highway investment stimulates private investment and can shape and channel growth



Economic Development Methods

- Survey and interview methods
- Market and comparable case studies
- Regional economic models
 - Dynamic simulation models (e.g., REMI)
 - Static Input-Output models (e.g., RIMS II)
- Hybrid modeling systems

FHWA Support to EEA/BCA

- Office of Asset Management will be building a “community of practice” website where it will list information on valuation of user costs and benefits and good practice methods for BCA and other methods of EEA
- Site will identify available software and resources to conduct BCA



Conclusions

- EEA has an important role in Transportation Asset Management
- EEA informs Decision Makers, but does not make decisions
- EEA tools are versatile and can accommodate a large number of variables as well as uncertainty
- FHWA will work with AASHTO to promote EEA and other elements of Transportation Asset Management

